

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

<p>(51) International Patent Classification 6 : H03F 3/189</p>	<p>A1</p>	<p>(11) International Publication Number: WO 97/47082</p> <p>(43) International Publication Date: 11 December 1997 (11.12.97)</p>
<p>(21) International Application Number: PCT/US97/09383</p> <p>(22) International Filing Date: 3 June 1997 (03.06.97)</p> <p>(30) Priority Data: 60/019,323 3 June 1996 (03.06.96) US</p>		<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).</p>
<p>(71) Applicant (for all designated States except US): SCIENTIFIC-ATLANTA, INC. [US/US]; One Technology Parkway South, Norcross, GA 30092-2967 (US).</p>		
<p>(71)(72) Applicants and Inventors: JELINEK, Catherine, W. [US/US]; 1234 Creek Laurel Drive, Lawrenceville, GA 30243 (US). PALAZZO, Mark, A. [US/US]; 2317 Roseberry Lane, Grayson, GA 30021 (US). VOGT, Stephan, W. [US/US]; 2610 Winth Rope Way, Lawrenceville, GA 30245 (US).</p>		<p>Published <i>With international search report.</i></p>
<p>(74) Agents: POTENZA, Joseph, M. et al.; Banner & Witcoff, Ltd., Suite 1100, 1001 G Street, N.W., Washington, DC 20001 (US).</p>		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav	TM	Turkmenistan
BF	Burkina Faso	GR	Greece		Republic of Macedonia	TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's	NZ	New Zealand		
CM	Cameroon		Republic of Korea	PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakhstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

**METHOD AND APPARATUS FOR ROUTING SIGNALS
THROUGH A CABLE TELEVISION SIGNAL DISTRIBUTION
AMPLIFIER**

Field of the Invention

This invention relates to circuit apparatus for routing signals to multiple CATV distribution amplifiers, and more particularly to a method and apparatus for internally dividing radio frequency and alternating current power signals from the input (upstream) port of an amplifier circuit and then routing the signals to
5 both an output port of the amplifier circuit and an additional port for coupling to a second amplifier circuit or a power inserter input.

Background

Cable television signal distribution systems comprise signal delivery systems that are analogous to the trunk and limbs of a tree. As cable television
10 systems grow, new limbs and branches must be provided to reach new subscribers, for example, in new subdivisions, apartment building complexes and the like or to reach further into the territory served by the cable television service provider. In order to facilitate delivery of services to potential subscribers from the serving CATV facility, typically referred to as a headend, CATV (community antenna
15 television/cable television) systems may require the installation of either two co-located distribution amplifiers for a new branch of the tree or that the signal be split at a point along the coaxial cable prior to entering the distribution amplifier. If the signal is to be split, it has been necessary to accomplish this by installing an external power passing splitter or coupler at or near the location of the amplifier,

an implementation of which is shown in Fig. 1. An external power passing splitter 16a may require its own housing or additional space within a pedestal at the amplifier location, not only for the splitter, but also for the routing of the coaxial cable into and out of the splitter. In underground or buried cable installations, pedestals are used to house amplifiers and in overhead cable environments, amplifier casings and the like are mounted on poles or hung from strands supporting the cable. In both of these environments, and particularly in a pedestal (buried) environment, space for additional splitters and amplifiers and the like is at a premium. The alternative of providing a larger pedestal is not only economically undesirable but may be unattractive and run afoul of local utility or environmental regulations. Additionally, AC (alternating current) power to the CATV system must be interrupted in order to splice an external splitter into the coaxial cable for provision of service to feed a new branch of subscribers. This can cause disruption of service to all subscribers downstream of the amplifier location. Creation of such a splice also requires a fair amount of work by a specialized craftsperson resulting in down time. Moreover, the resulting splice may require additional shielding when completed to prevent serving signal loss or noise ingress, for example, from power, broadcast radio frequencies or telecommunications lines located nearby.

Objects of the Invention

Accordingly, a primary object of the present invention is to provide a relatively simple, plug-in method for dividing a CATV signal at a desired point along the serving CATV distribution plant.

In particular, an object of the present invention is to split CATV signals via an internal signal divider located on an amplifier motherboard within an amplifier housing for containment within a pole or strand mounted casing or pedestal.

5 A further particular object of this invention is to reduce the work, system downtime, and space requirements for extending a cable distribution system to reach additional subscribers of a cable television system or for adding a power inserter into the system.

Summary

10 In accordance with the principles of the present invention, a connector is provided on an amplifier motherboard for receiving at least one removable plug-in board for tapping off incoming RF and AC signals to provide an external output or for permitting power insertion to the amplifier. The motherboard and plug-in board, when installed, are both contained within an amplifier housing. The plug-in
15 board in one embodiment contains a power passing, radio frequency choke or inductor and either a directional coupler or a splitter, along with an input (upstream) port and two output (downstream) ports. By input port here and throughout the following description is meant the upstream signal input from a headend and such an input as so defined permits both downstream and upstream
20 signal flow, for example, for bidirectional telecommunications signals including digital data (for example, CATV system status monitoring), voice (for example, telephony) or video (for example, for remote broadcast feeds upstream or for video conferencing). Also, by output port is intended the downstream side of the element and such an output port permits both downstream and upstream signal

flow. By distribution amplifier, whenever used herein, is intended the provision of amplification circuitry permitting a single input and a single or multiple outputs for serving mutiple branches of the CATV distribution plant.

5 This plug-in board of the present invention is intended to be inserted into a receiving connector of a motherboard on which is mounted amplification circuitry and may be inserted either in the field or at the factory. The connector passes signals directly to the amplification circuitry when the plug-in card is not plugged into the connector and, when the plug-in is installed, the plug-in board routes radio frequency (RF) signals arriving on a coaxial or other cable input port
10 of the amplifier motherboard through a directional coupler to the amplification circuitry, from which the signals are further routed to the main amplifier output port. The plug-in board additionally taps off and feeds the incoming RF signals to a second output port of the amplifier motherboard. In this manner, potential subscribers of new branches of a CATV distribution plant may be served with
15 minimal disruption of service to existing downstream customers. Also, the additional external port may be utilized, not only for serving new customers, but as a power insertion point for providing power to the amplifier if, for example, insufficient power is available at either its input or output.

20 When the plug-in is installed, AC power signals arriving on the coaxial input port are fed through alternating current passing inductors (radio frequency choke coils) to the new second, tapped off, port, as well as through another radio frequency choke to the main amplifier output port via power supply and divider circuitry for providing power for the amplification circuitry of the motherboard and any other upstream or downstream amplifiers as desired. If the plug-in board

is removed, the RF signals arriving at the input port are fed directly through the amplification circuitry of the motherboard to the main amplifier output port and the AC signals are fed directly through the radio frequency choke to power supply and divider circuitry for powering the amplification circuitry and to the main
5 amplifier output port.

Brief Description of the Drawings

Fig. 1 is a simplified schematic diagram of a prior art arrangement having a distribution amplifier connected to a separate, external power passing tap; and

Fig. 2 is a simplified schematic diagram of the amplifier motherboard 10
10 and plug-in 24 for containment within a housing with an internal splitter plug-in board 24 coupled to a connector of the motherboard including amplification circuitry 20 of the present invention.

Detailed Description of the Preferred Embodiment

Referring to a prior art distribution amplifier arrangement with external tap
15 shown in Fig. 1, an amplifier housing 10a is connected to an external power passing and radio frequency signal divider 16a. Divider 16a must be physically installed in a CATV distribution plant when a new branch for serving potential new subscribers is required, resulting in some service down time and increased space requirements, for example, in a pedestal. Divider 16a receives an RF and
20 an AC signal on input port 12a, and couples these signals through output port 14a to the input port 12b of amplifier 10a. Tap 16a also routes the AC and radio frequency signals on input port 12a to output port 14b for distribution to other amplifiers. The RF signal on input port 12b of amplifier 10a is fed through

amplification circuitry 20a via capacitors (which pass radio frequency signals and block low frequency AC power) to output port 14c. The AC signal on input port 12b is fed through radio frequency choke circuits 22b to power supply and director circuitry 22a within housing 10a which in turn provides power to amplifier 20a and any other components requiring power.

Referring to Fig. 2, an embodiment of the amplifier 10 of the present invention is shown in parallel with an additional amplifier 10n. Amplifier 10 has an input port 12 coupled through an internal signal divider provided by a removable plug-in splitter or coupler board 24 to amplification circuitry 20 and then to output port 14. By convention in the drawing of Figure 2, connector switches J1 and J2 and shunts K1 and K2 are shown in a connector state when plug-in 24 is plugged in. A connector comprising the signal entry and exit points of dotted line plug-in board 24 provides direct signal feed to amplifier 20 and power supply 22 when plug-in board 24 is not inserted in the motherboard 10, shown in dotted line as well. That is, common points c are connected to shunt points b permitting RF signal pass through to amplifier circuit 20. When the plug-in 24 is not installed, output port 16 is not connected. That is, shunt points f and g are shown connected when the plug-in is installed but are broken when the plug-in is not installed. Motherboard 10 and optional plug-in 24 contained within an amplifier housing conserves space in a pedestal or other amplifier casing in either an overhead or buried cable environment. The removable board 24 is preferably a plug-in that is inserted into a motherboard 10 on which is mounted the amplification and power supply and divider circuitry 20 and 22. Insertion of the board 24 may be done either in the field or at the factory. When the plug-in 24 is

installed, board 24 may be additionally coupled through second output port 16 to another amplifier motherboard 10 with yet another plug-in connector permitting n amplifiers and so n branches to be inserted in the CATV distribution plant, represented as amplifier 10 n in the drawing. Moreover, with the plug-in installed, port 16 may be utilized as a power inserter point for supplying power to power supply and divider 22, for example, in the event insufficient AC power is provided at either port 12 or port 14.

AC and RF signals are received on input (upstream) port 12, which, in the preferred embodiment, is a coaxial cable. AC signals can also be received from downstream amplifiers via port 14 or any external amplifier port 16. AC power signals are decoupled from the radio frequency path through radio frequency choke coil 26 to power supply and divider circuitry 22 on motherboard 10. Power circuitry 22 includes power directors and power supplies generally known in the art, and is used to power the amplification circuitry 20 and other components requiring power of motherboard 10. AC power and radio frequency signals are fed to (or received from) subscribers or downstream amplifiers in the CATV system via output port 14 or output port 16 (when the plug-in 24 is installed and operatively connected). In particular, the AC power signals are fed through radio frequency choke 28 and second output port 16 on coupler board 24 toward additional amplifier 10 n while the radio frequency signals are isolated from power signals via capacitors 30 and 36, divided at divider 32 and output at output port 16.

In one embodiment, RF signals arriving on port 12 from the CATV headend are fed to the line amplification circuitry 20 through a low frequency filter

30 (normally isolating amplifier 20 from AC power) and through a directional coupler 32 located on plug-in board 24. Coupler board 24 routes the RF signals coming in on port 12 through high pass (and AC power block) filter 36 via output port 16 to downstream amplifier 10n. In a second embodiment, a splitter may be
5 used in place of the directional coupler 32. Amplification circuitry 20, which is constructed by any of the techniques well-known to one skilled in the art, amplifies the RF signals received from coupler 32. These amplified RF signals are then fed through high pass filter 34 to output port 14. In any embodiment in which both forward and reverse directions of transmission are provided, diplexers
10 and reverse path amplification circuitry (not shown) are used for separating and amplifying the upstream transmission radio frequency band of channels.

In the embodiment of Fig. 2, high pass filters 30, 34 and 36 are advantageously implemented as capacitors and low pass filters 26, 28 and 38 may comprise radio frequency choke coils, but they may also be implemented by any
15 of the myriad other methods well-known to those skilled in the art of the invention.

When coupler or plug-in board 24 is not present, RF signals arriving on input port 12 from the CATV headend are routed directly to amplification circuitry 20. AC power signals arriving on input port 12 are fed directly through
20 radio frequency choke coil 26 to power circuitry 22 for powering amplification circuitry 20. The shunt path from K1 shunt point e to the input of power supply and divider circuit 22 does not comprise a portion of plug-in 24. It is located on the motherboard in the depicted embodiment. The AC power signals are also fed

from the power circuitry 22 via radio frequency choke coil 38 to the amplifier output port 14 and thence to further downstream amplifiers or subscribers..

Plug-in board 24 eliminates the need for an external tap in order to reroute the signal arriving on input port 12 to amplifier 10n. This has space advantages, saving not only space that would be taken by the external signal divider 16a (shown in Figure 1) but by the additional coaxial cable needed. Further advantages are obtained from elimination of the need for craftsman time spent to splice in the external tap and of system down time necessitated by interruption of serving (or upstream) radio frequency signal and AC power during the splicing operation.

Thus, there has been shown and described circuit apparatus for routing signals to a new external port of an amplifier circuit which meets the objectives sought. While the depicted embodiment shows all signal divider circuitry as a single plug-in, the plug-in circuitry may be configured as two or more plug-ins. Each such plug-in may be similarly installed in an instant and still not disrupt service. An advantage of providing two plug-ins, for example, may be for component placement. For example, by mounting AC components 28 and 36 in a different location, both AC and RF signal path lengths can be shortened. Also, certain AC power components may be permanently located on the motherboard and intended to actuated only when the plug-in is inserted. This approach minimizes the need for low inductance grounding of the signal divider to ensure that the RF choke 28 sufficiently isolates RF and AC signals.

As already indicated, the signal divider may be used for power insertion. In such an embodiment, it is only necessary to enable the AC power portion of the plug-in 24 and not the divider 32. With the plug-in installed, a simple jumper or actuation of motherboard switches J1, J2 to connect points b, c will shunt out the signal divider and preserve the AC feed path through points f and g.

Further modifications and substitutions by one of ordinary skill in the art are considered to be within the scope of the present invention, which is not to be limited except by the claims which follow.

CLAIMS

What is claimed is:

- 1 1. Circuit apparatus for routing signals through at least one amplifier
2 comprising, in combination:
3 amplification circuitry containing at least one input port and at
4 least one output port; and
5 an internal signal divider coupled between one of said input ports
6 of said amplification circuitry and the remainder of said amplification circuitry,
7 said internal signal divider having at least one input port, an output port and an
8 external output.
- 1 2. The circuit apparatus of claim 1, wherein said internal signal divider
2 comprises, in combination:
3 a splitter, said splitter having an input coupled to said internal
4 signal divider input and first and second outputs, said first output being coupled
5 to said internal signal divider output and said second output being coupled to
6 said external output; and
7 a power decoupler, said power decoupler operating to transfer
8 ac power from said amplifier circuit input to said external output.
- 1 3. The circuit apparatus of claim 1, wherein said internal signal divider
2 comprises, in combination:

3 a directional coupler, said directional coupler having an input
4 coupled to said internal signal divider input and first and second outputs, said
5 first output being coupled to said internal signal divider output and said second
6 output being coupled to said external output; and

7 a power decoupler, said power decoupler operating to transfer
8 ac power from said amplifier circuit input to said external output.

1 4. The circuit apparatus of claim 1, wherein said external output is
2 connected to additional circuit apparatus.

1 5. The circuit apparatus of claim 1, wherein said internal signal divider is
2 resident on a removable board adapted for plug-in attachment to a board
3 containing said amplifier circuitry.

1 6. The circuit apparatus of claim 2, wherein said amplification circuitry
2 comprises, in combination:

3 amplifier circuitry;

4 power circuitry for powering said amplifier circuitry;

5 a first power decoupler coupled between said line-amplification
6 circuitry input port and said power circuitry; and

7 a second power decoupler coupled between said power circuitry
8 and said amplification circuitry output port.

1 7. The circuit apparatus of claim 6, wherein said amplification circuitry
2 further comprises, in combination:

3 a first high pass filter coupled between said amplification
4 circuitry input port and said internal signal divider input; and

5 a second high pass filter coupled between said amplifier circuitry
6 and said amplification circuitry output port.

1 8. The circuit apparatus of claim 3, wherein said amplification circuitry
2 comprises, in combination:

3 amplifier circuitry;

4 power circuitry for powering said amplifier circuitry;

5 a first power decoupler coupled between said amplification circuitry
6 input port and said power circuitry; and

7 a second power decoupler coupled between said power circuitry and said
8 amplification circuitry output port.

1 9. The circuit apparatus of claim 8, wherein said amplification circuitry
2 further comprises, in combination:

3 a first high pass filter coupled between said amplification circuitry input
4 port and said internal signal divider input; and

5 a second high pass filter coupled between said amplifier circuitry and
6 said amplification circuitry output port.

1 10. The circuit apparatus of claim 7, wherein said internal signal divider
2 further comprises a third high pass filter coupled between said splitter and said
3 external output.

1 11. The circuit apparatus of claim 9, wherein said internal signal divider
2 further comprises a third high pass filter coupled between said directional
3 coupler and said external output.

1 12. A method for routing a combination radio frequency and alternating
2 current signal through an amplifier, comprising, in combination, the steps of:
3 providing amplification circuitry containing at least one input port and
4 at least one output port;
5 providing an internal signal divider coupled between one of said input
6 ports of said amplification circuitry and the remainder of said amplification
7 circuitry, said internal signal divider having at least one input port, an output
8 port, and an external output; and
9 tapping off said signals from said amplification circuitry input using said
10 internal signal divider to provide said external output.

1 13. The method of claim 12, further including the steps, in combination, of:
2 tapping off said radio frequency signal using a splitter, said splitter
3 having an input coupled to said internal signal divider input and first and second

- 4 outputs, said first output being coupled to said internal signal divider output and
- 5 said second output being coupled to said external output; and
- 6 decoupling said ac power signal between said amplifier circuit input and
- 7 said external output with a power decoupler.

1 14. The method of claim 12, further including the steps, in combination, of:
2 tapping off said radio frequency signal using a directional coupler, said
3 directional coupler having an input coupled to said internal signal divider input
4 and first and second outputs, said first output being coupled to said internal
5 signal divider output and said second output being coupled to said tap output;
6 and
7 decoupling said ac power signal between said amplifier circuit input and
8 said external output with a power decoupler.

1 15. The method of claim 12, further comprising the step of coupling said
2 external output to additional amplifier circuitry.

1 16. The method of claim 14, further comprising the step of high pass
2 filtering said radio frequency signal before said signal enters said splitter, after
3 said splitter, before said external output, and after said remainder of said
4 amplification circuitry.

1 17. The method of claim 14, further comprising the step of high pass
2 filtering said radio frequency signal before said signal enters said directional
3 coupler, after said directional coupler, before said external output, and after
4 said remainder of said amplification circuitry.

1 18. Circuit apparatus for routing signals through an amplifier comprising,
2 in combination,
3 amplification circuitry and
4 a connector for receiving a plug-in signal divider, the plug-in signal
5 divider, when installed, for providing an external output, said connector for
6 providing radio frequency signals to said amplification circuitry regardless of
7 whether said plug-in signal divider is installed in said connector.

1 19. Circuit apparatus as recited in claim 18 wherein said connector
2 comprises first and second switches for shunting out the signal divider when the
3 plug-in signal divider is installed, the external port for inserting power to the
4 amplification circuitry.

1 20. Circuit apparatus as recited in claim 19 wherein said connector
2 comprises a removable shunt coupled to a radio frequency choke of the plug-in,
3 the shunt operative to permit power insertion for powering the amplification
4 circuitry when the plug-in is installed.

1/2

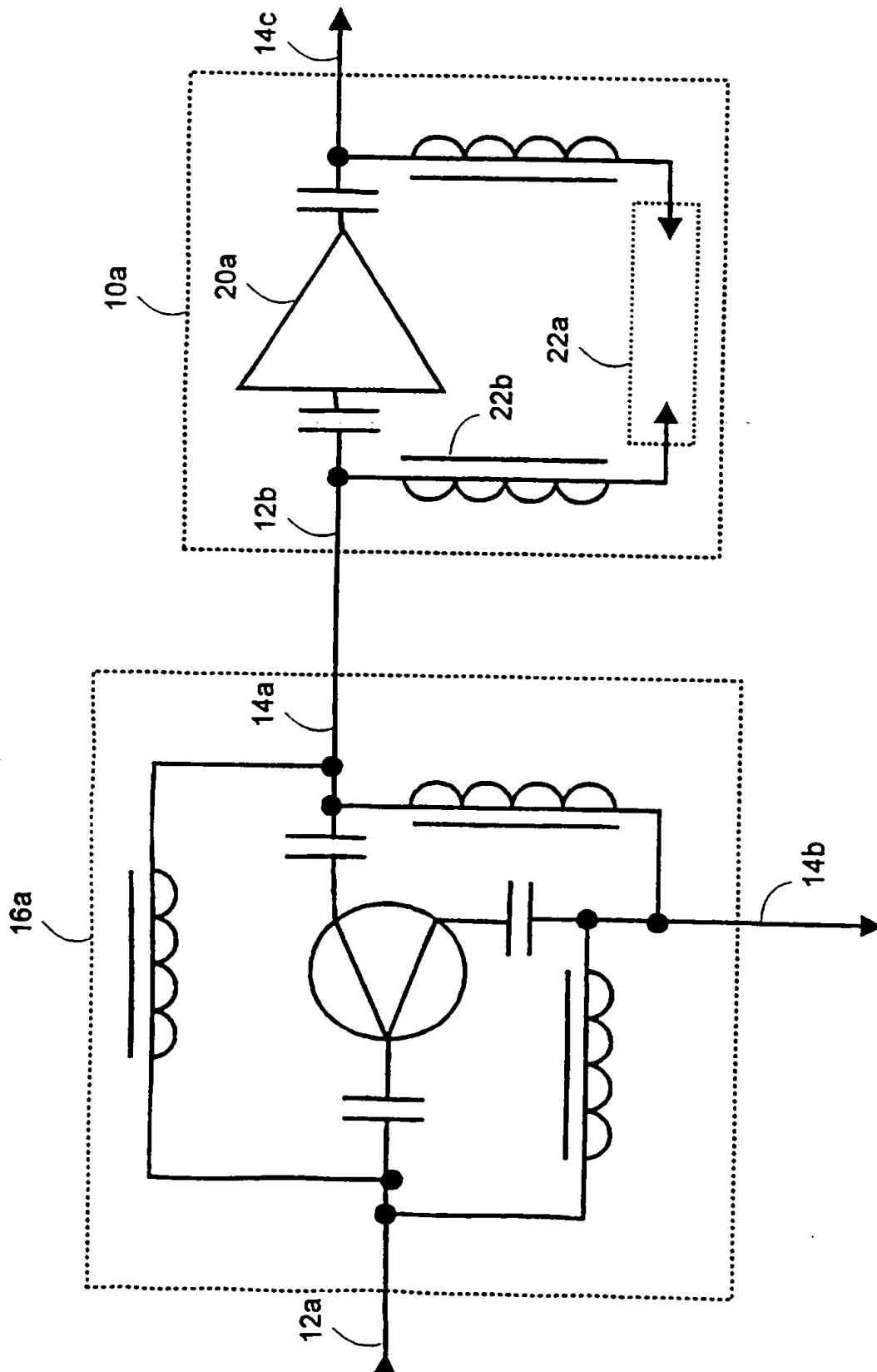


Fig. 1 (Prior Art)



BNSDOCID: <WO__9747082A1_I_>

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/09383

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : H03F 3/189
US CL : 330/65

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 330/51,65,66,67,68,127; 348/707

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,055,809 A (TAKEUCHI et al.) 25 October 1977	1,4,5,12,15,18
--	(25/10/77)	-----
Y	see the entire document.	2,3,13,14,16,17

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	* T	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
* A		document defining the general state of the art which is not considered to be of particular relevance
* E		earlier document published on or after the international filing date
* L		document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
* O		document referring to an oral disclosure, use, exhibition or other means
* P		document published prior to the international filing date but later than the priority date claimed
	* X	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
	* Y	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
	* &	document member of the same patent family

Date of the actual completion of the international search
18 AUGUST 1997

Date of mailing of the international search report
03 SEP 1997

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Authorized officer

Steven J. Mottola

Facsimile No. (703) 305-3230

Telephone No. (703) 308-4914

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US97/09383

B. FIELDS SEARCHED

Electronic data bases consulted (Name of data base and where practicable terms used):

APS

search terms: CATV, amplifier, housing, plug in, divider or splitter

THIS PAGE BLANK (USPTO)